Integrating remote sensing and citizen science to study the environmental context and ecological consequences of returning avian predators

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Citizen Science for Earth Systems NNX17AI68A

Animal predators in an urban World

Urban colonization

Gallo et al. (2016) Ecological Applications

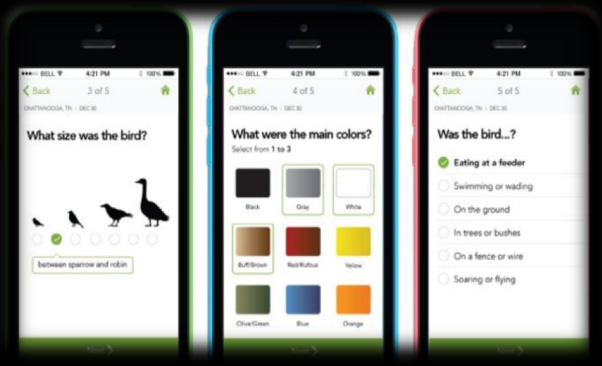
Rutz (2008) Journal of Animal Ecology

Accipiter Hawks

Is colonization driven by urban features?

Is colonization driven by prey availability?

Citizen science and urban ecology



Citizen science: Project FeederWatch

1987-present (> 70,000 people)

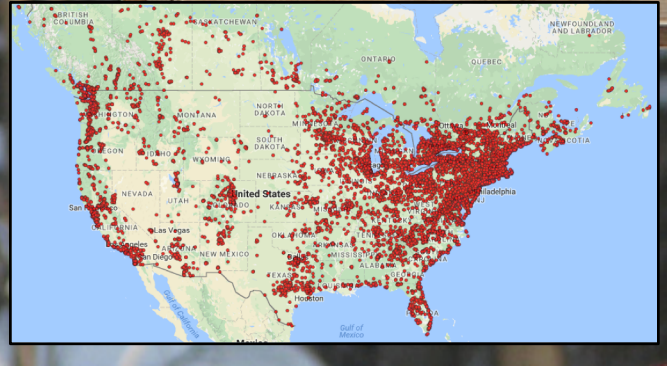
Repeated counts ***November – April***

In 2016…

22,082 participants

140,034 checklists

6.8 million birds

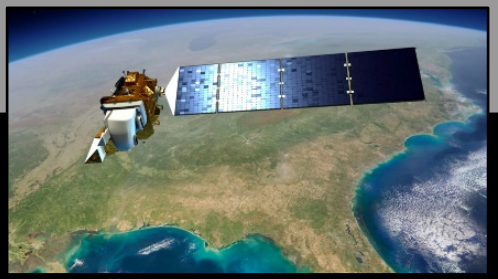


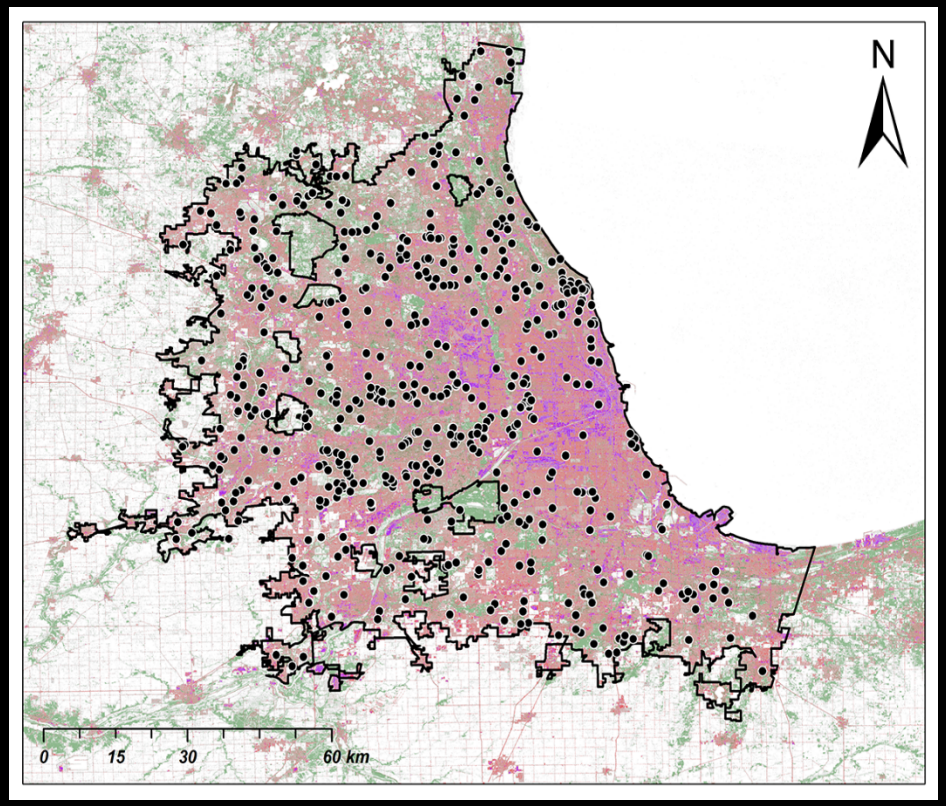
TheCornellLab

BIRD STUDIES CANADA
ÉTUDES D'OISEAUX CANADA

Occupancy Dynamics – *(1996-2016)*

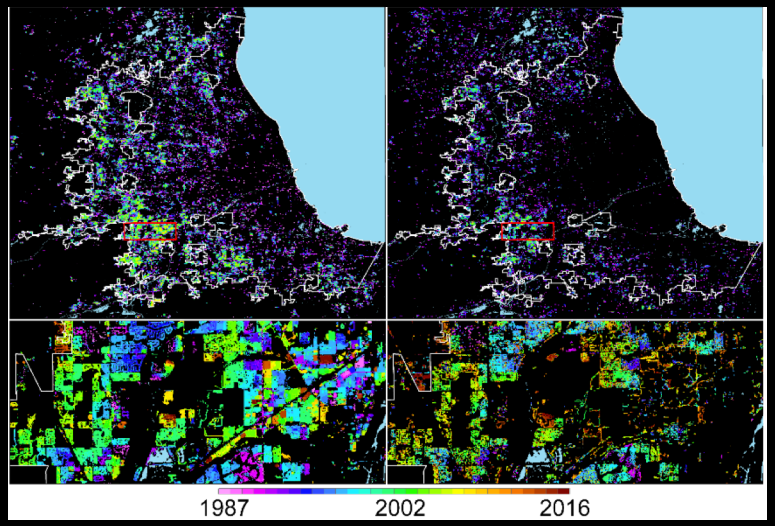
n = 554





Landsat

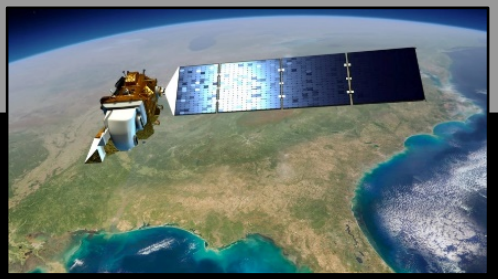
- % imperviousness
- % tree canopy cover

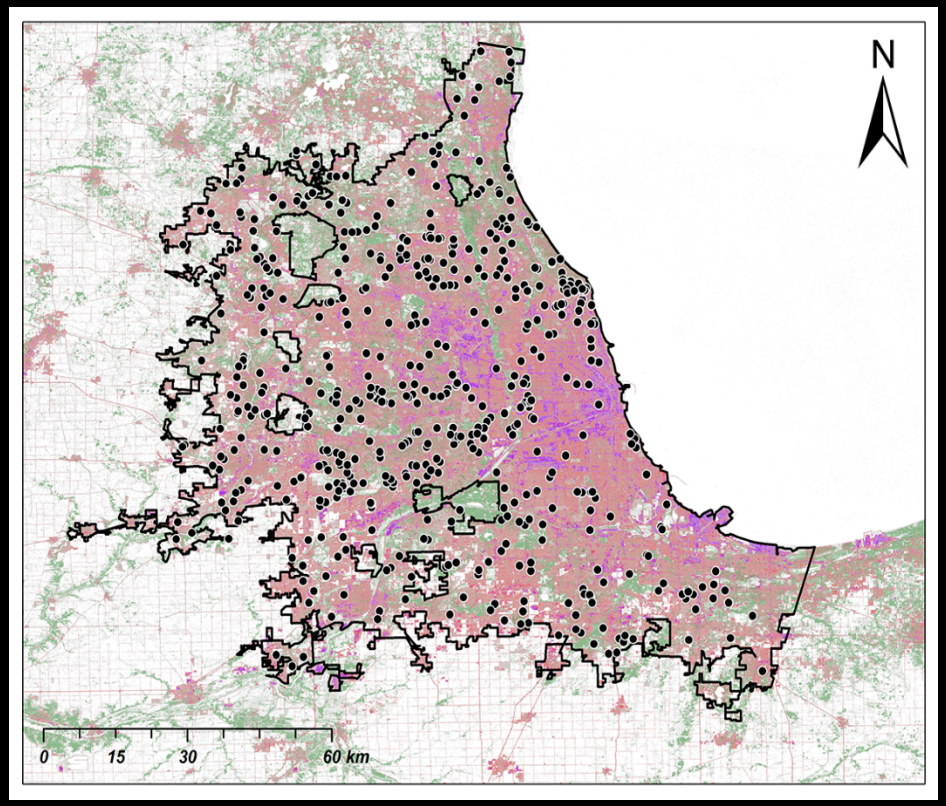


Yin et al. (2017)

Occupancy Dynamics – *(1996-2016)*

n = 554





Landsat

- % imperviousness
- % tree canopy cover

3km buffer around sites *(Chiang et al. 2012)*

Prey availability

Occupancy Dynamics – *(1996-2016)*

Dynamic Occupancy Model

Occupancy Dynamics – *(1996-2016)*

Dynamic Occupancy Model

Detection Process

i = site; k = year; j = repeat survey (week)

Detection process:

$$Logit(p_{i,j,k}) = \tau_{effort[i,j,k]}$$

Occupancy Dynamics – *(1996-2016)*

Dynamic Occupancy Model

Detection Process

i = site; k = year; j = repeat survey (week)

Detection process:

$$Logit(p_{i,j,k}) = \tau_{effort[i,j,k]} + \tau_1 * tmin_{i,j,k}$$

Occupancy Dynamics – *(1996-2016)*

Dynamic Occupancy Model

Detection Process

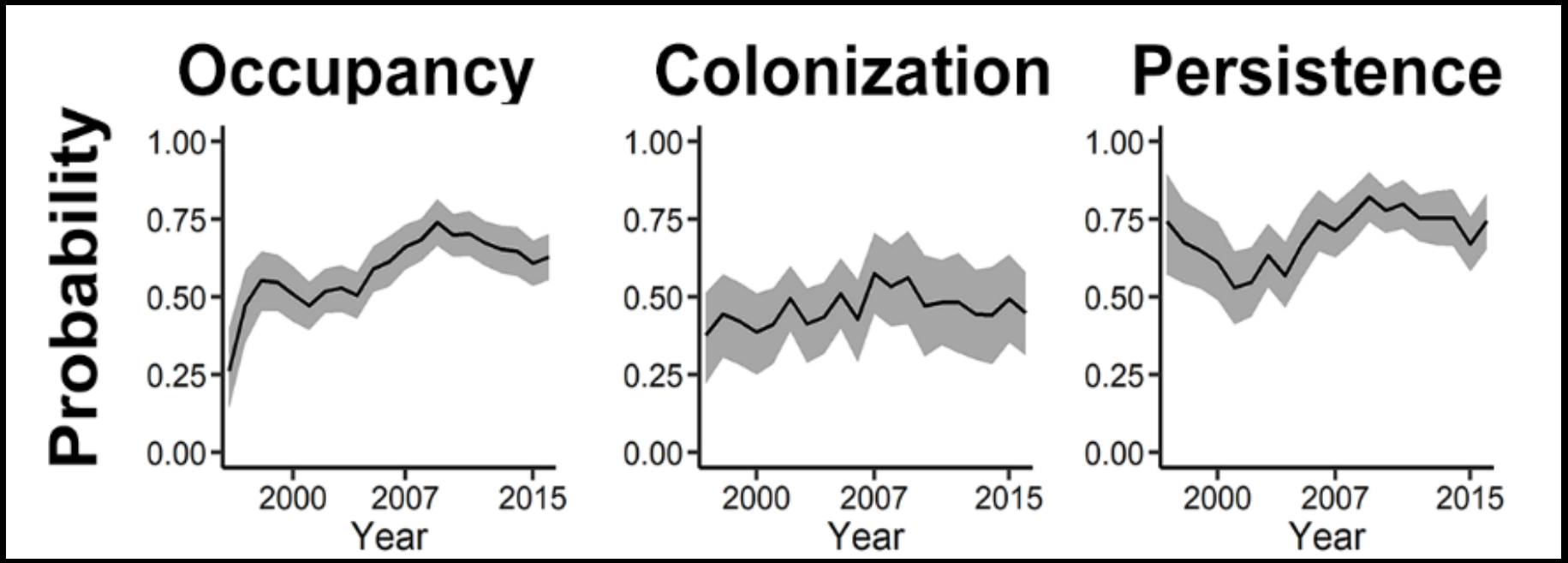
Ecological Process

Ecological process:

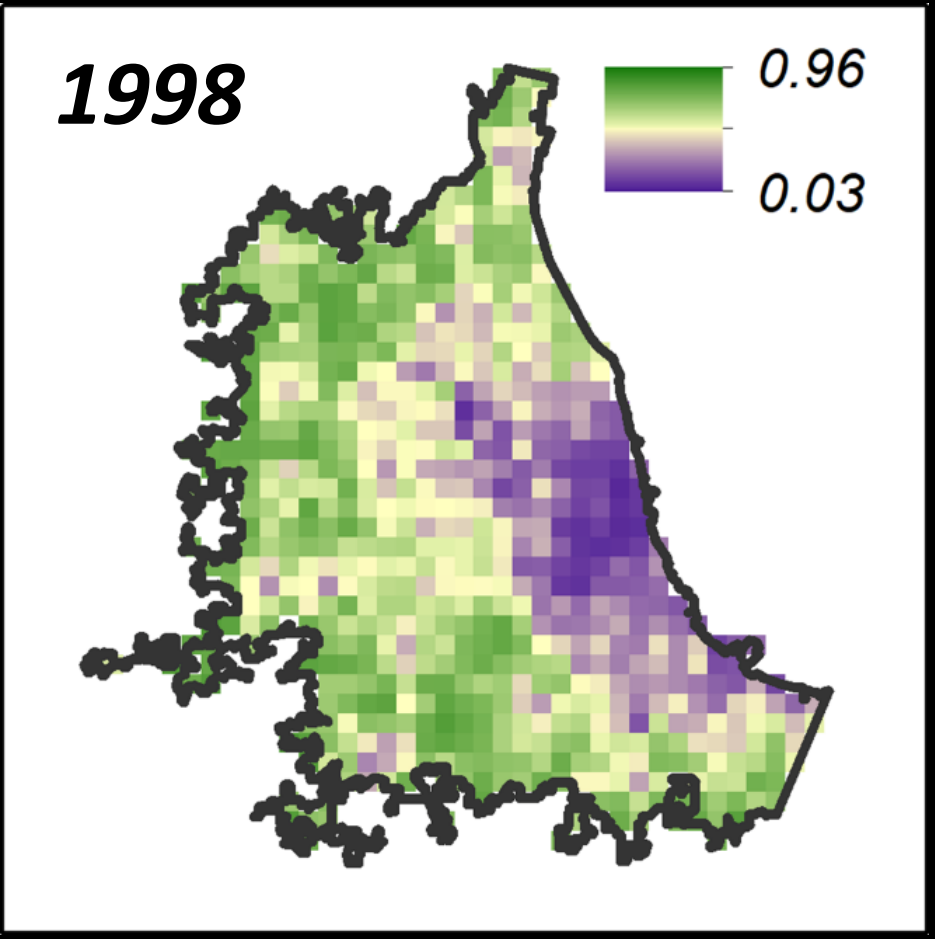
$$\text{Logit}(\phi_k) = \beta_0 + \beta_1 * treeCov_i + \beta_2 * ImpSur_i + \beta_3 * preyAbund_{i,k}$$

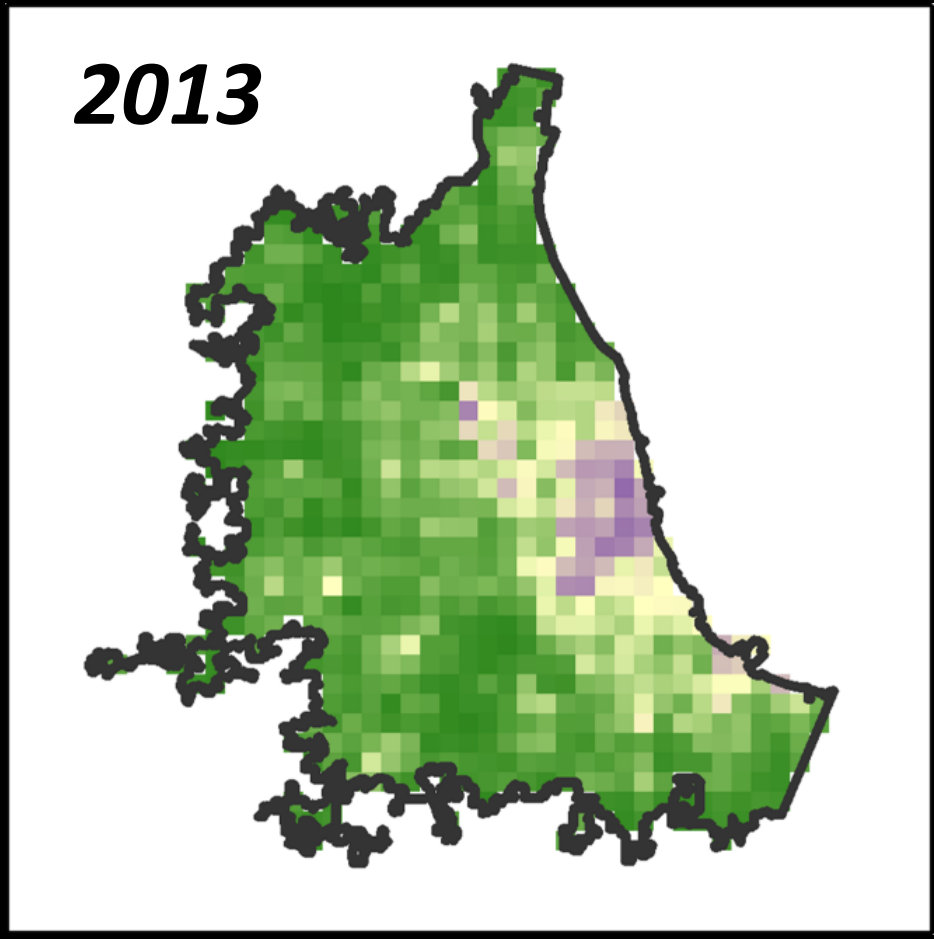
$$\text{Logit}(\gamma_k) = \alpha_0 + \alpha_1 * treeCov_i + \alpha_2 * ImpSur_i + +\alpha_3 * preyAbund_{i,k_{1,i}}$$

Occupancy Dynamics

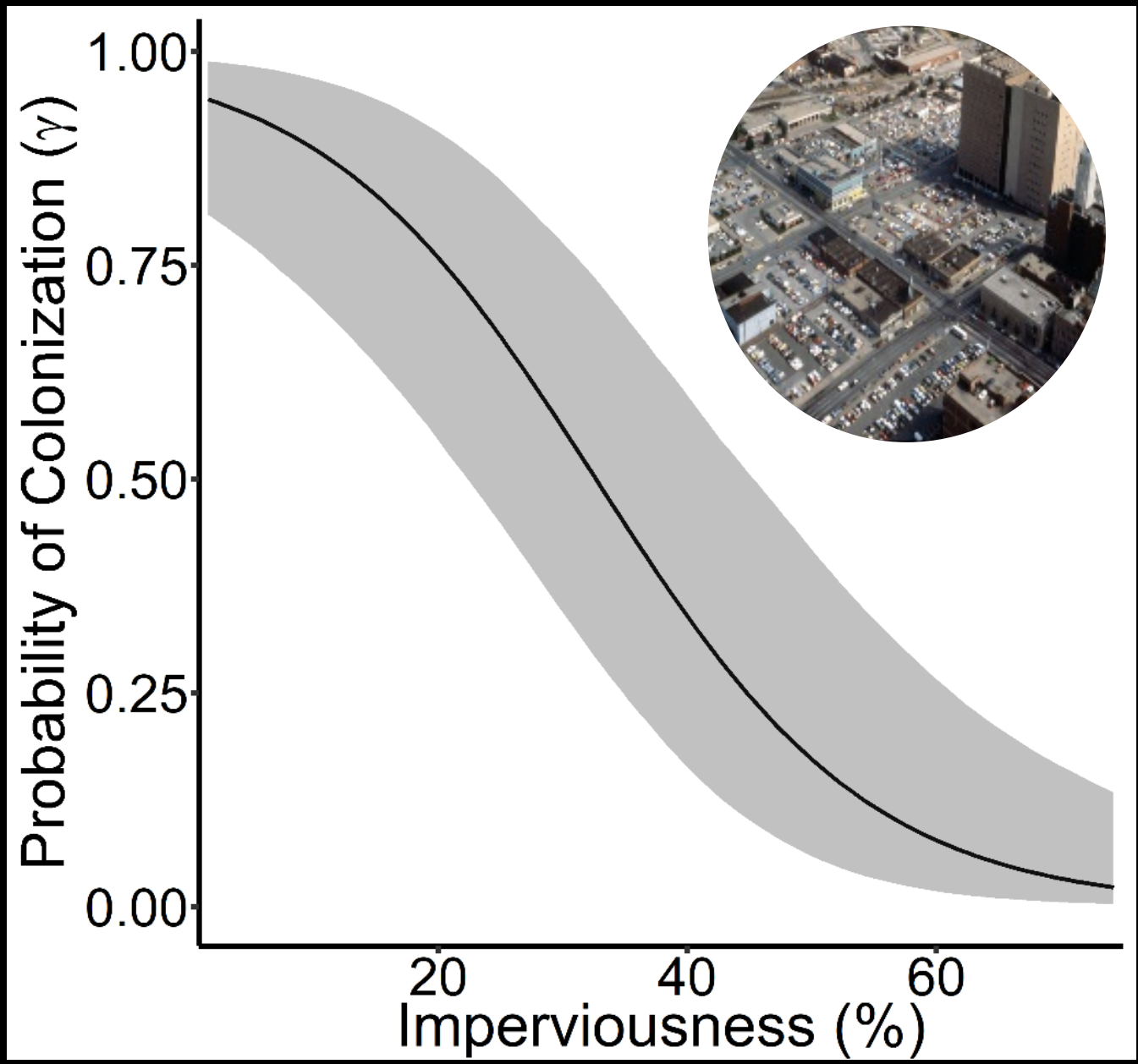


Occupancy Dynamics – *predictions*

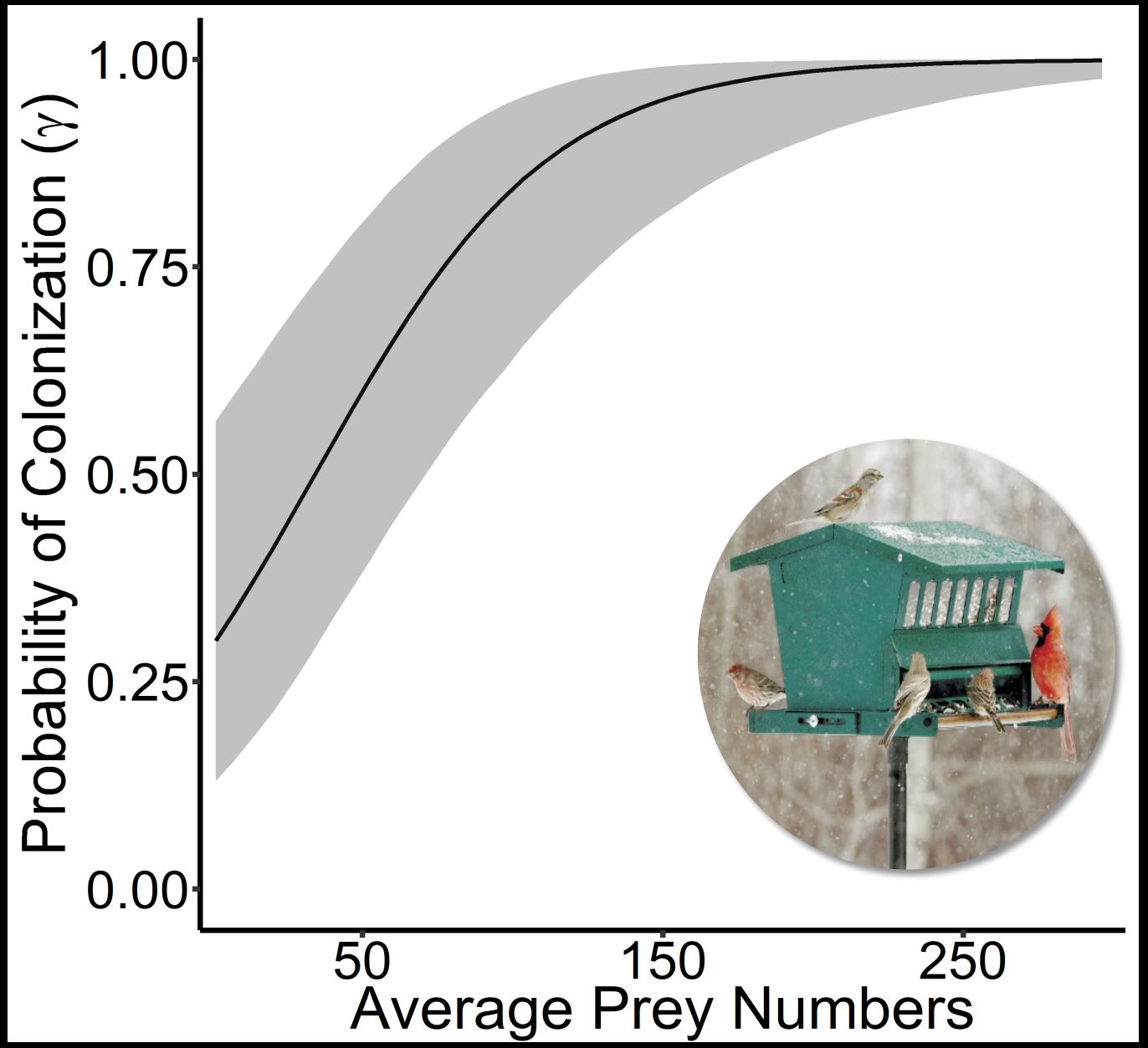




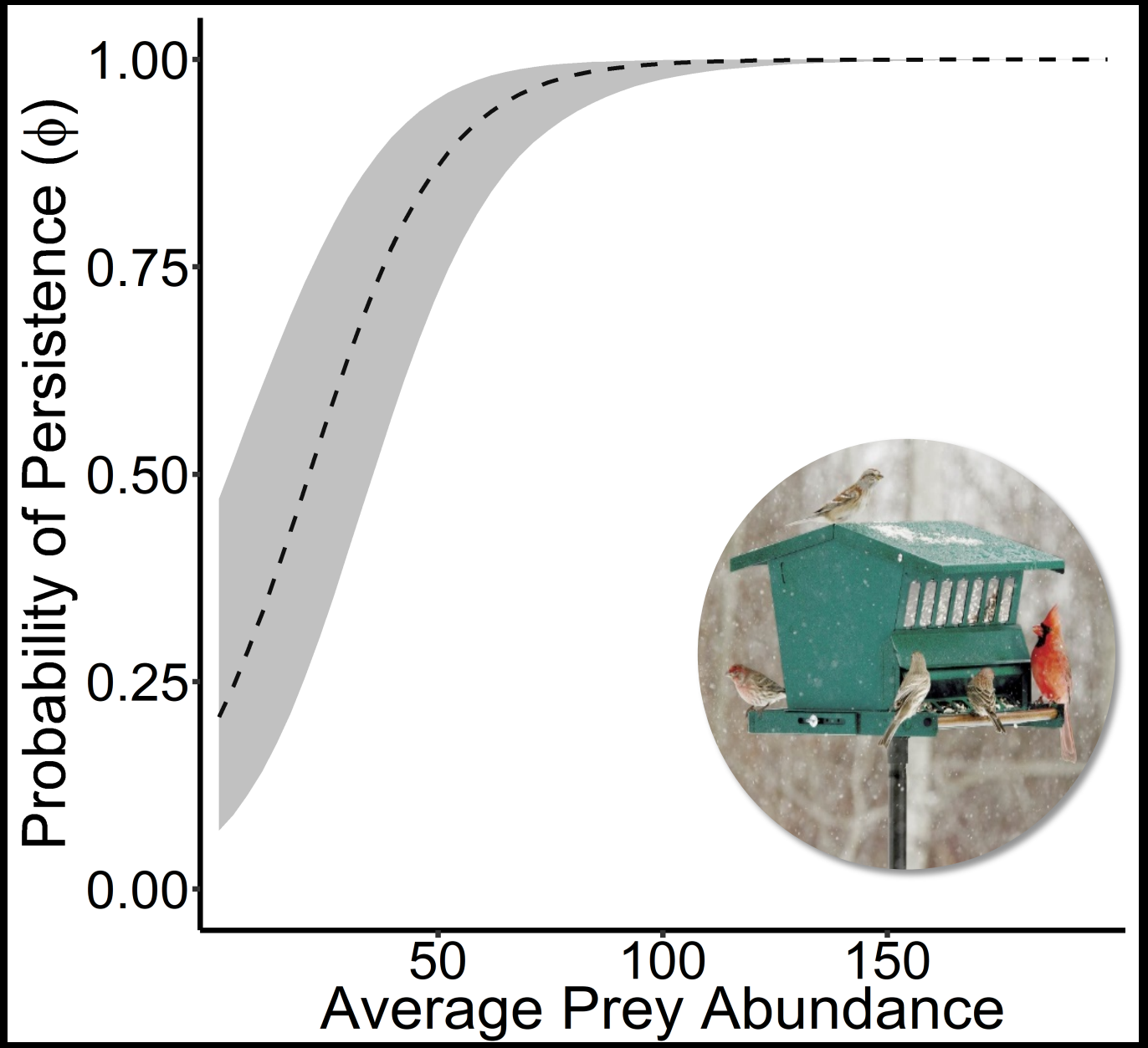
Occupancy Dynamics - *colonization*



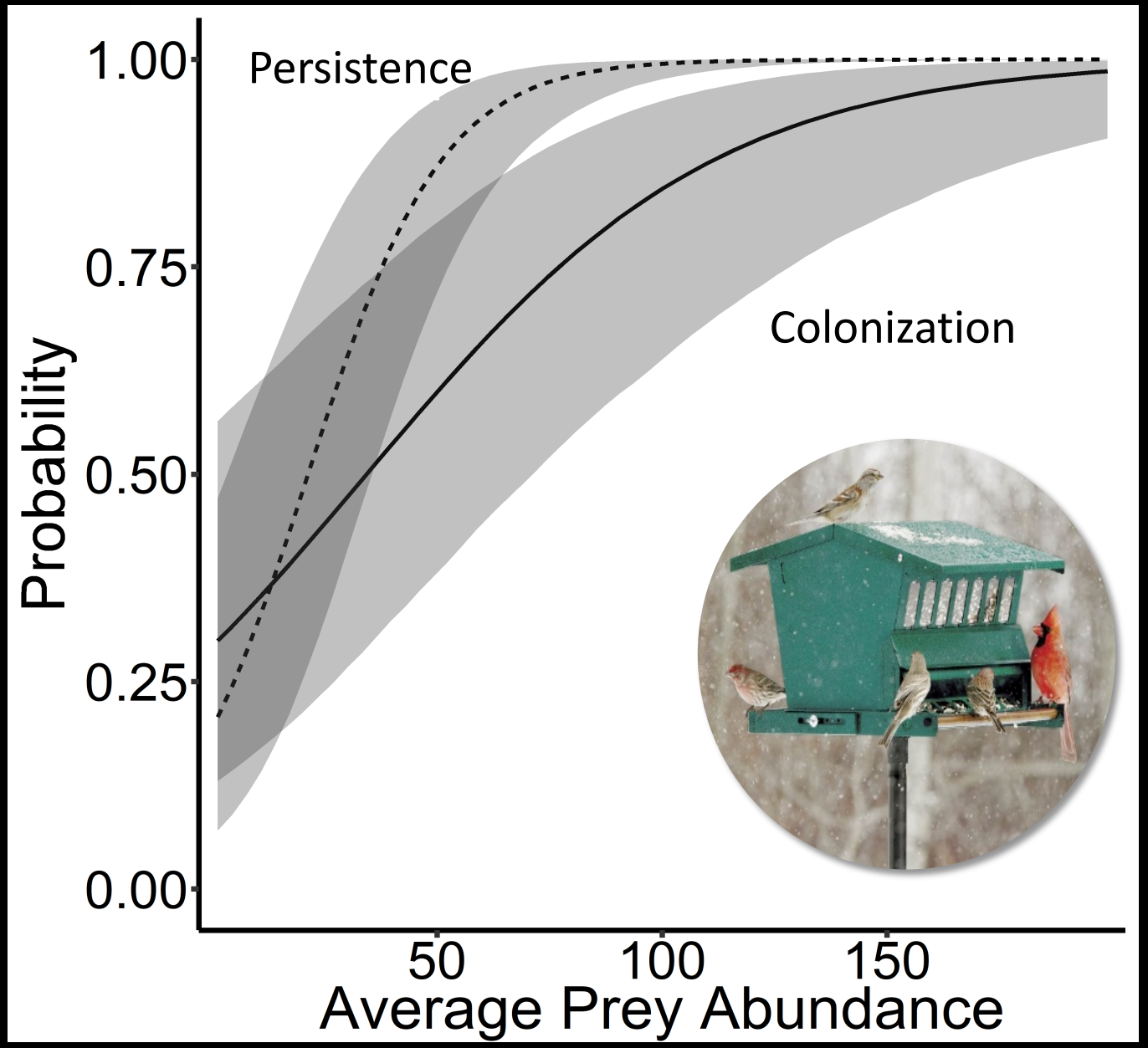
Occupancy Dynamics - *colonization*



Occupancy Dynamics - *persistence*



Occupancy Dynamics



Conclusions

Remote sensing can inform the study of urban colonization by animal predators

Hawks ***colonized*** along the outskirts of the city and were less likely to colonize areas of high ***imperviousness***

Once colonized, urban features play a less important role, persistence was ***dependent on prey***

Urban landscapes of fear – *predation risk*

Few failures are as unforgiving as the failure to avoid a predator:
being killed greatly decreases future fitness
(Lima and Dill 1990)

Citizen science meets behavioral ecology

Develop an approach for assessing antipredator behavior in birds that can be mass-deployed to citizen scientists

Antipredator behavior

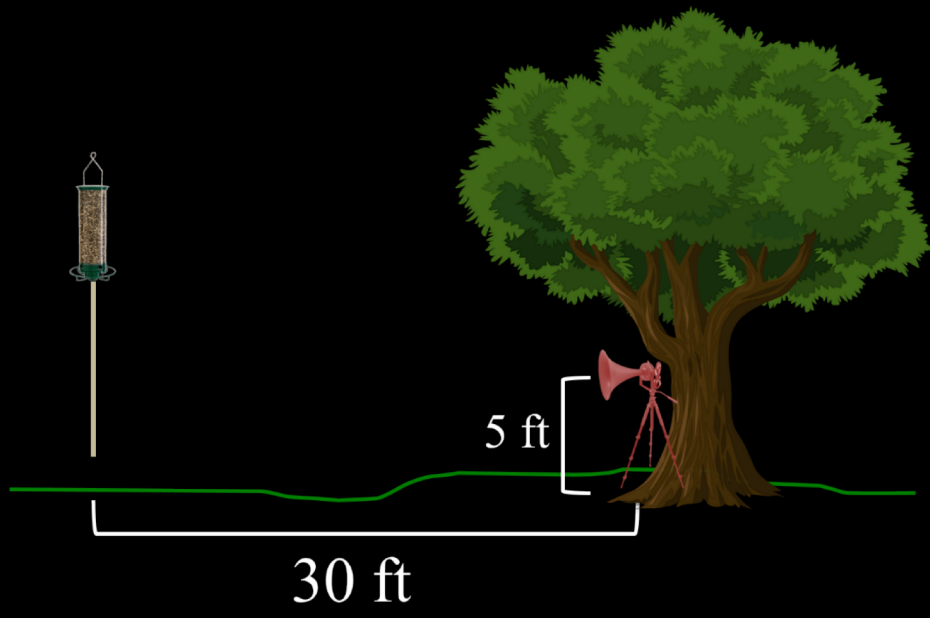
Playback experiment - “Hawk-Kits”

Predator stimulus

Antipredator behavior

Playback experiment - “Hawk-Kits”

Predator stimulus



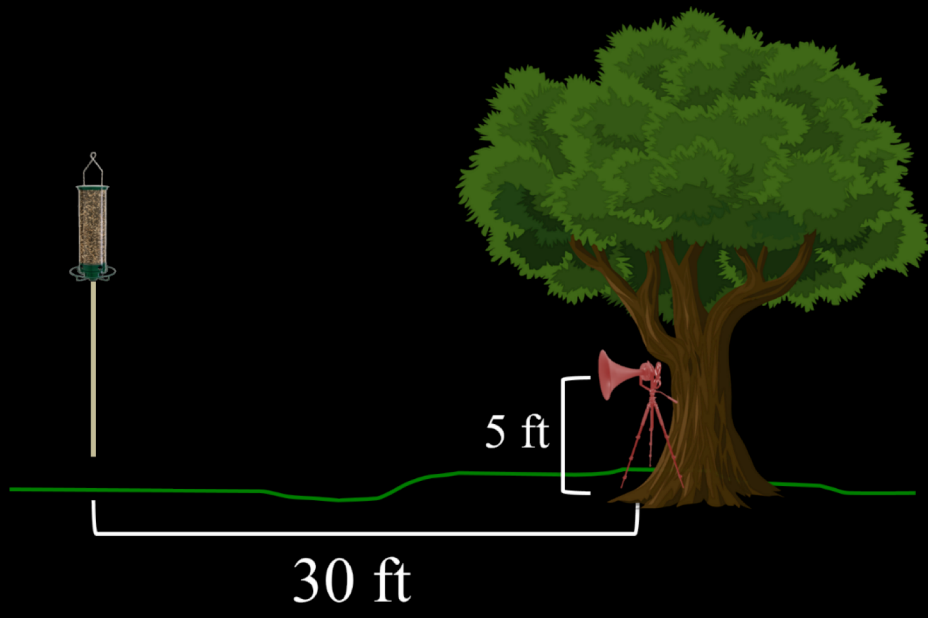
Antipredator behavior

Playback experiment - “Hawk-Kits”

Predator stimulus

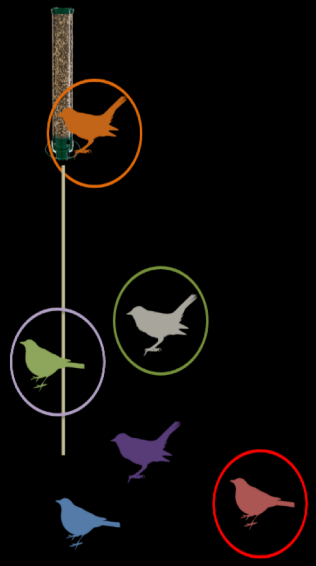
Control

Treatment



Behavioral observations

Observation periods



~ 15 min

5 min — Pre-playback

5 min — Playback

5 min — Post-playback

Behavioral observations

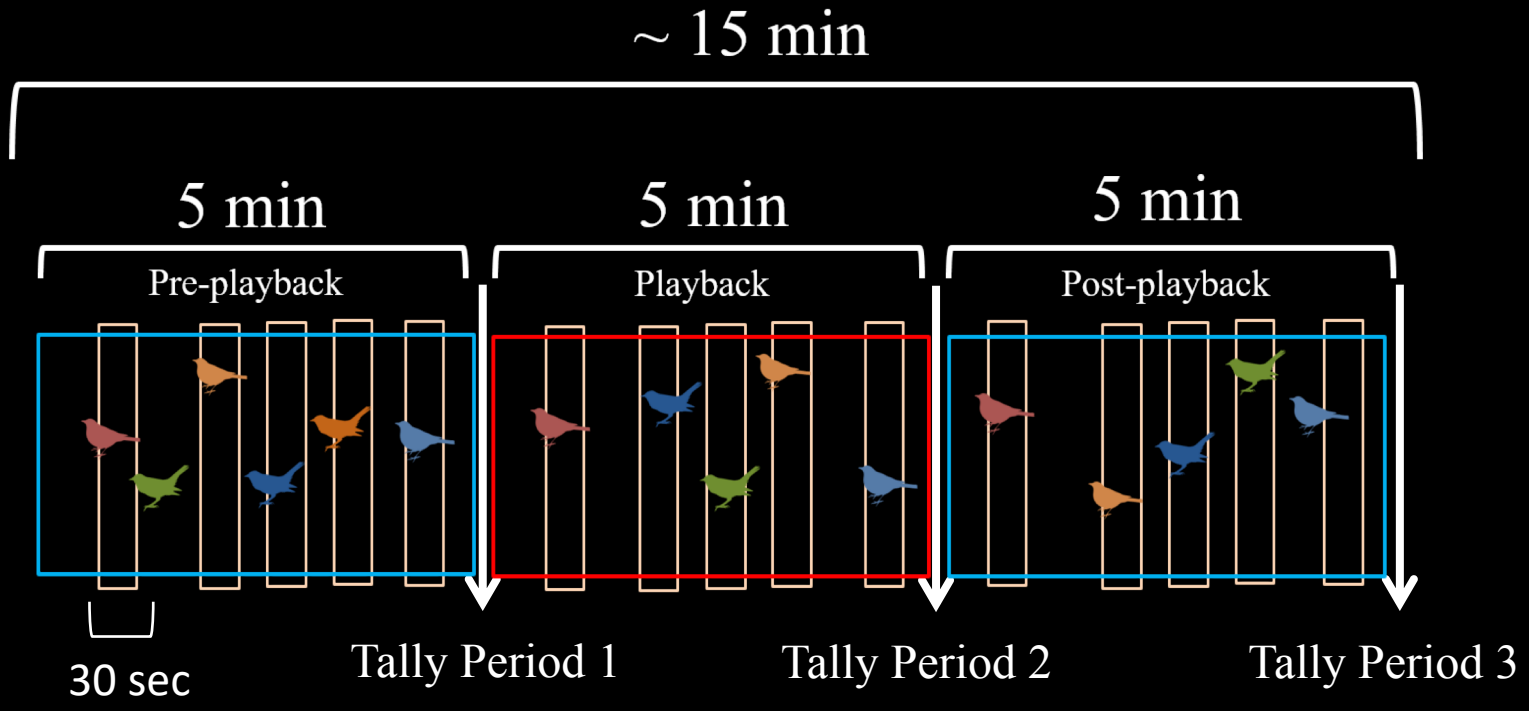
Observation periods

Tally records

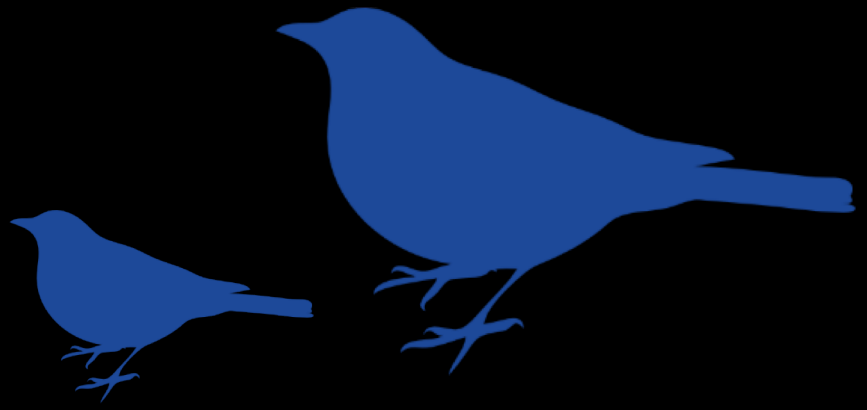
Counts of species

Behavioral observations

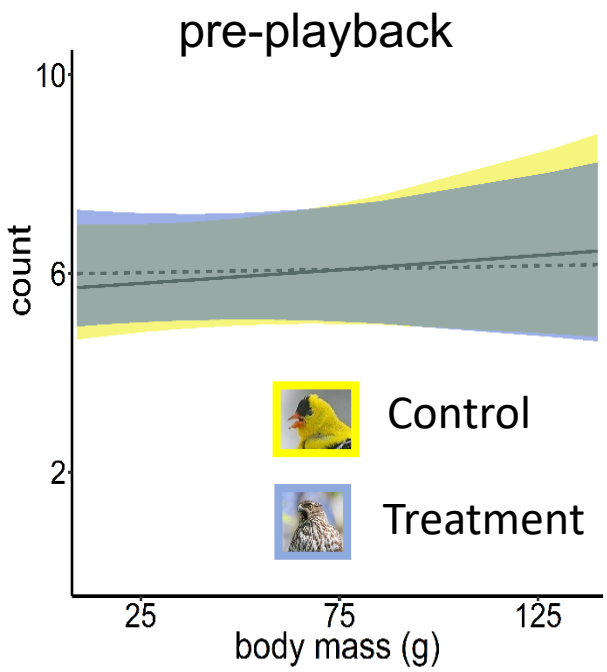
Head up and pecking



Analysis

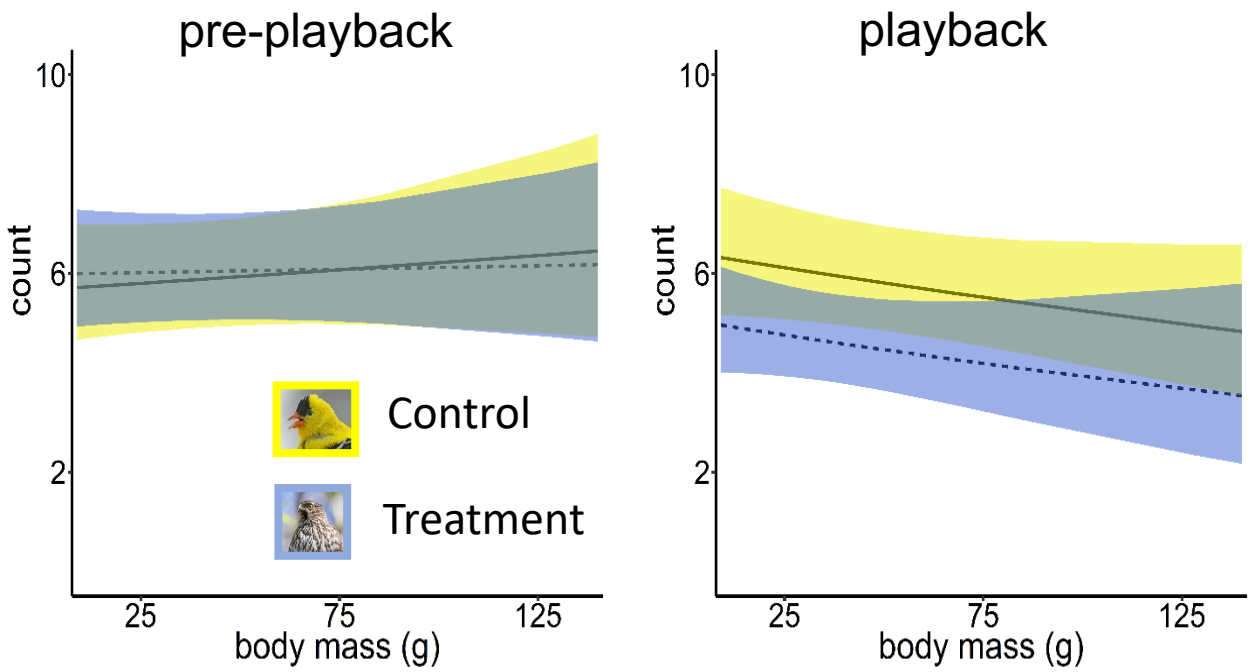


Flock Size



n = 1089

Flock Size



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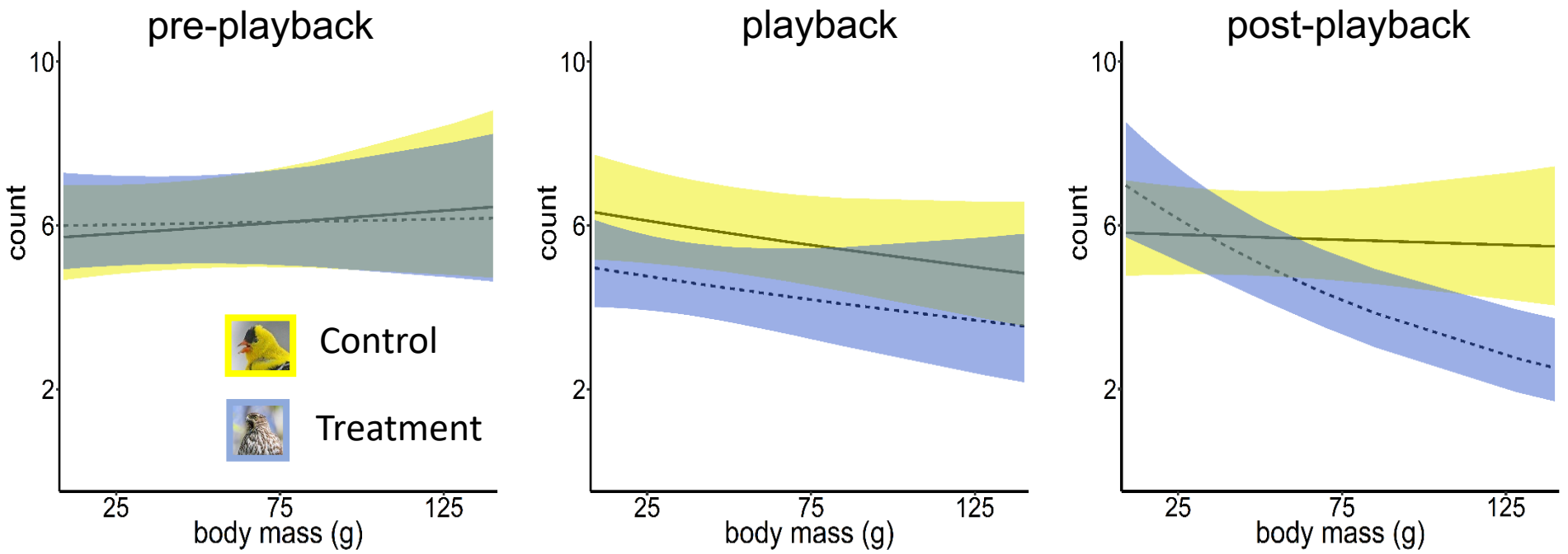
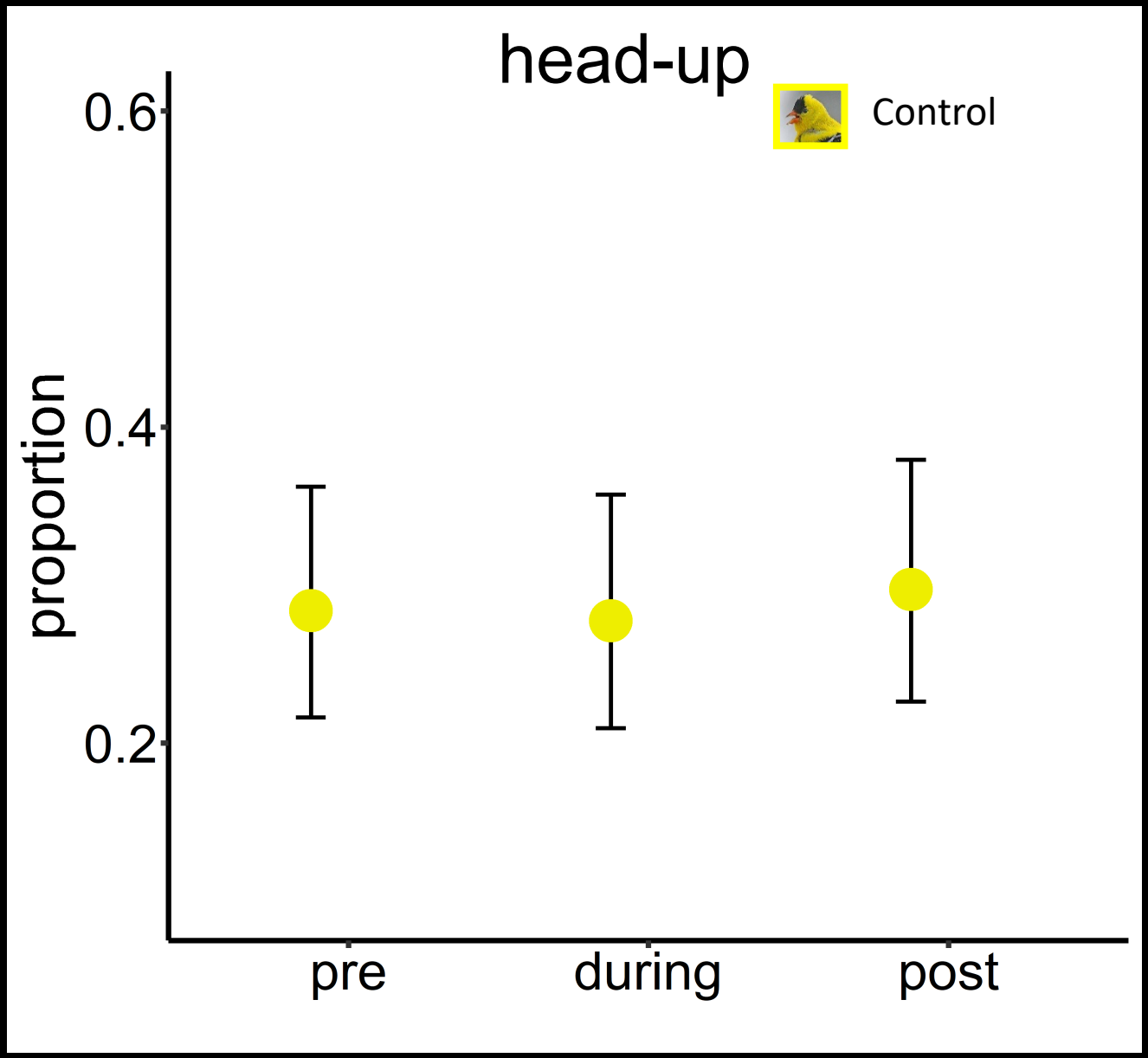


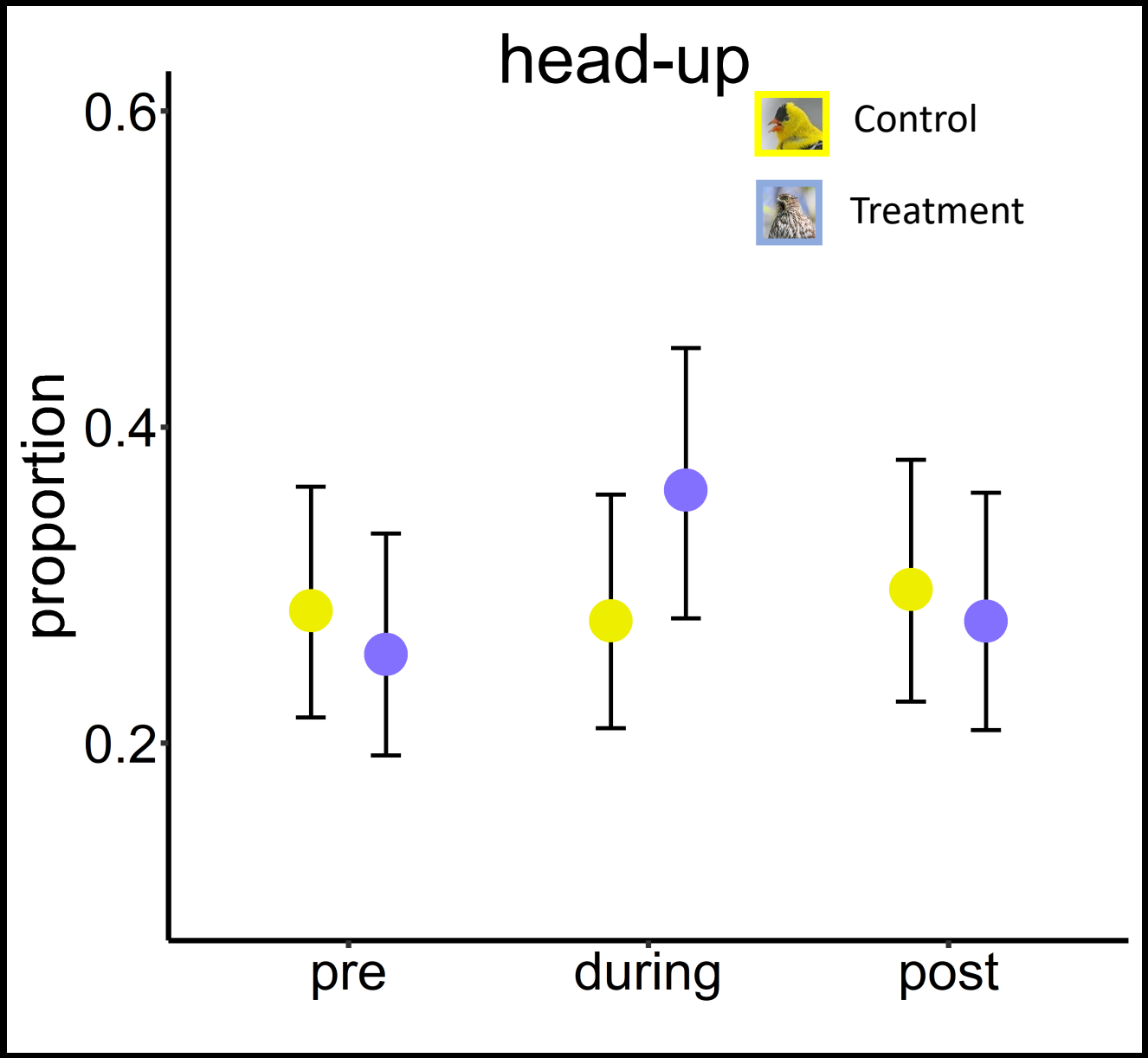
n = 1089

Vigilance



n = 788

Vigilance



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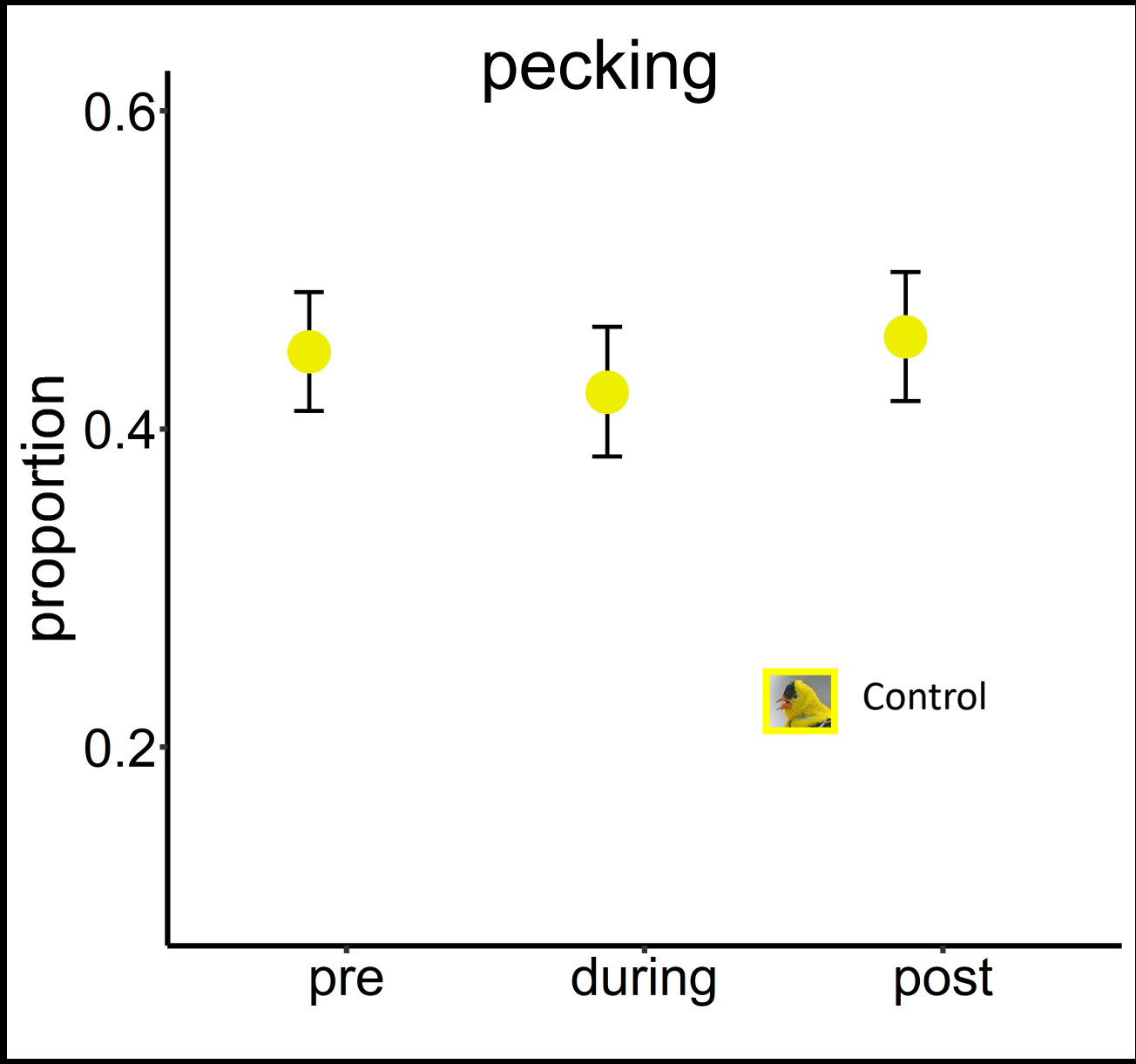
Foraging



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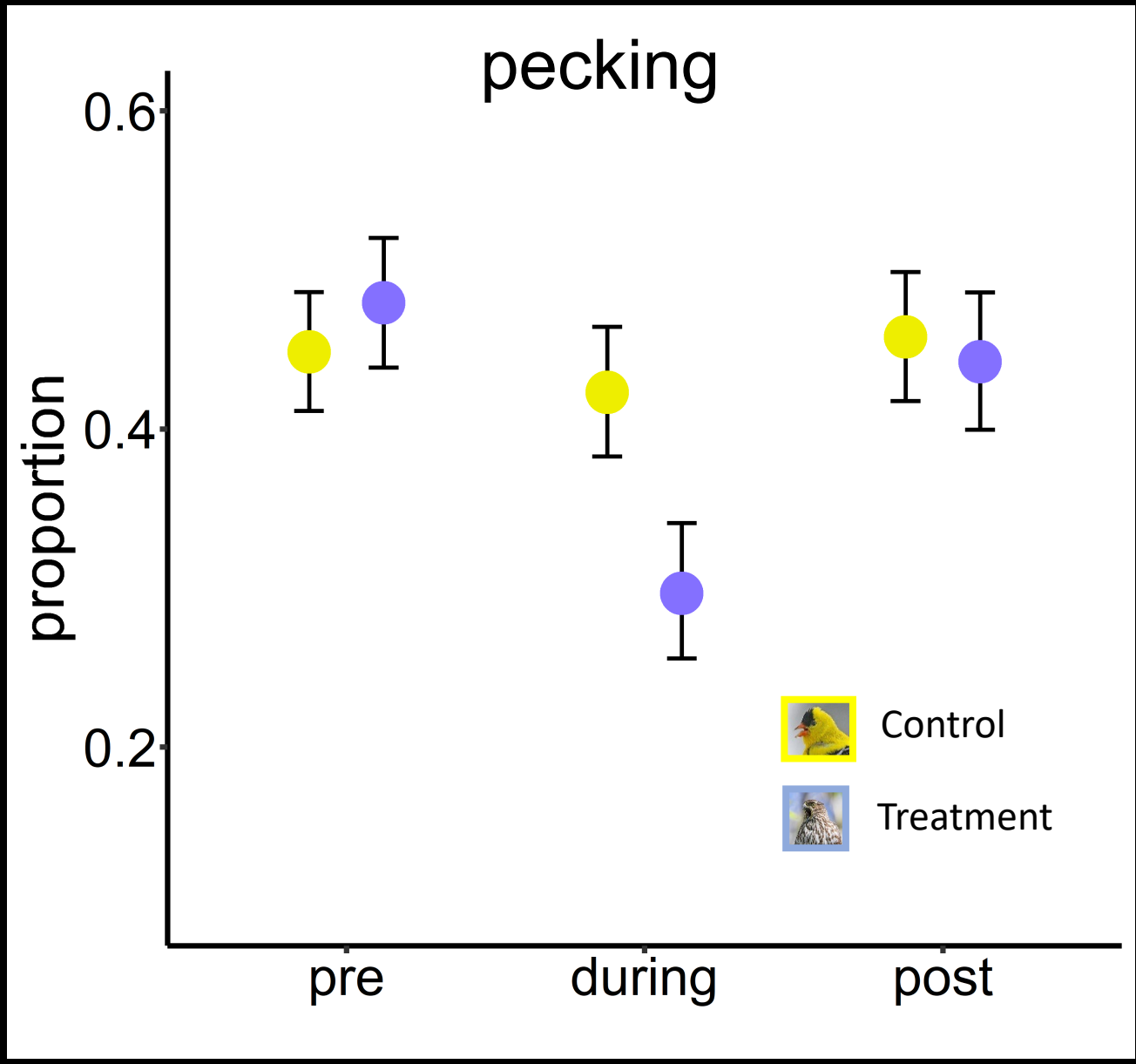
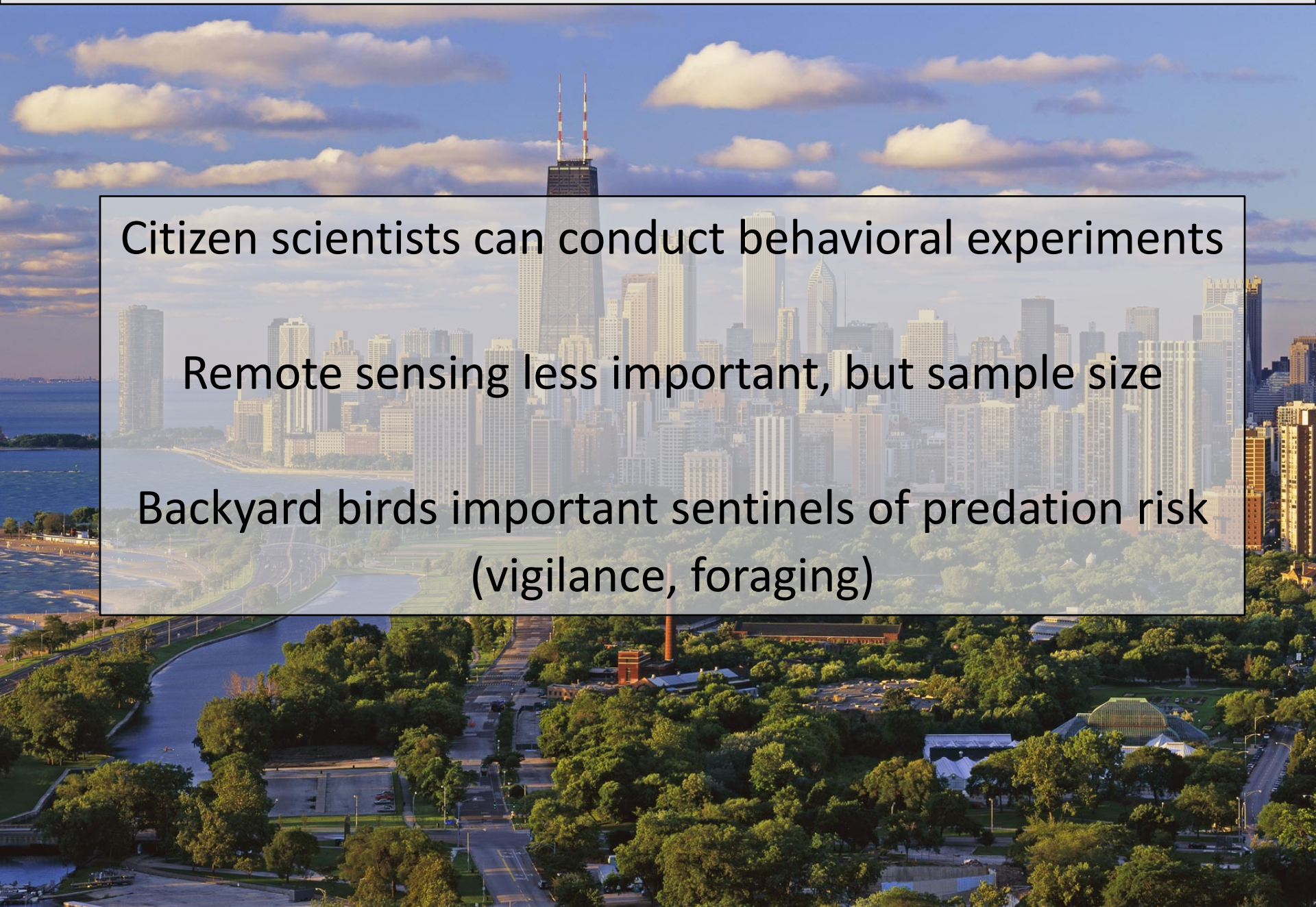
Foraging



n = 788

Conclusions



Citizen scientists can conduct behavioral experiments

Remote sensing less important, but sample size

Backyard birds important sentinels of predation risk (vigilance, foraging)

Implications

Predator recovery is a tenant of conservation biology

Citizen science and remote sensing are **critical tools in urban ecology**

Untapped potential of citizen science in **behavioral ecology**

Wildlife conservation and education in cities is a critical mission

Acknowledgments

This research would not be possible without the hard work of thousands of volunteer FeederWatch participants (*not passive sensors*)

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NASA